

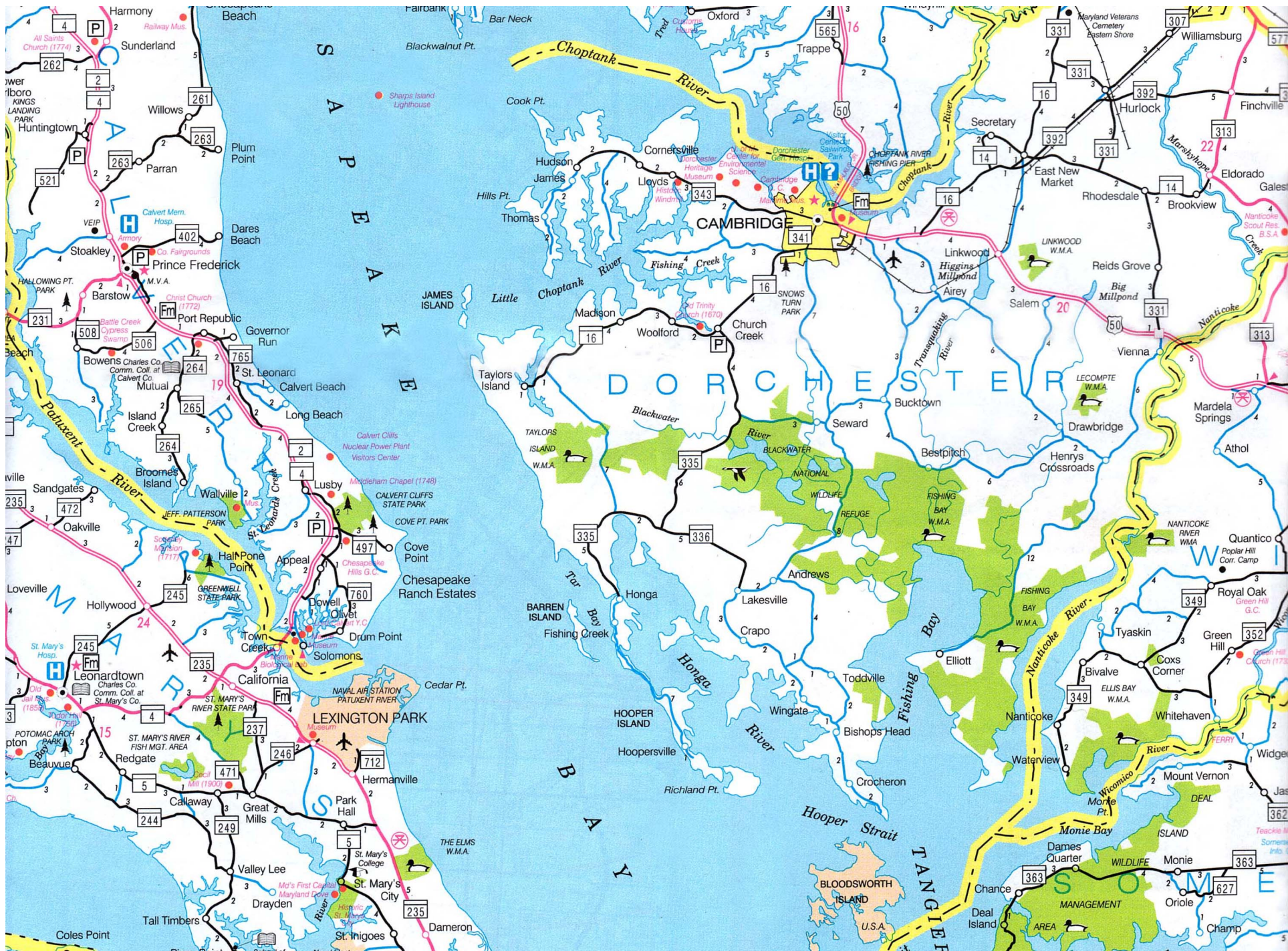
A satellite map of the Mid-Atlantic region, showing the Chesapeake Bay and surrounding land. The land is green, indicating vegetation, and the water is dark. The map is oriented with North at the top.

ADAPTING TO SEA LEVEL RISE & GLOBAL CHANGE IN THE MID- ATLANTIC REGION

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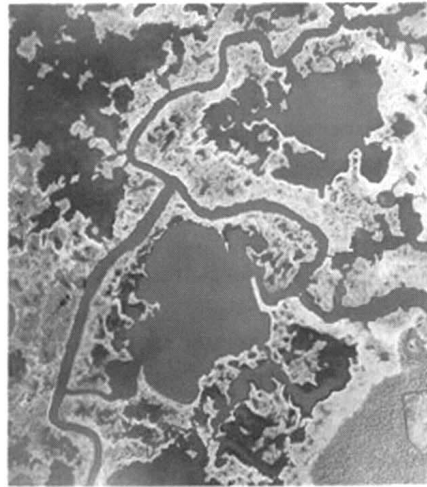




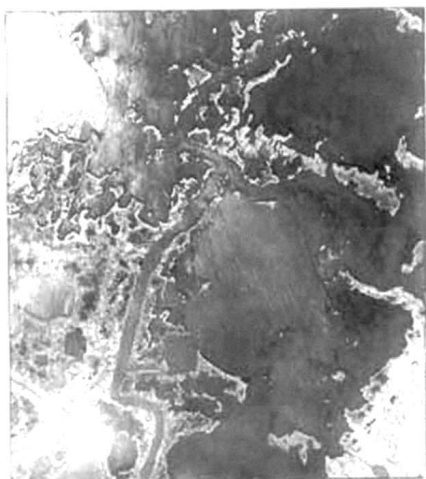
Marsh disappearance at confluence of Blackwater NWR & vibracoring in a marsh



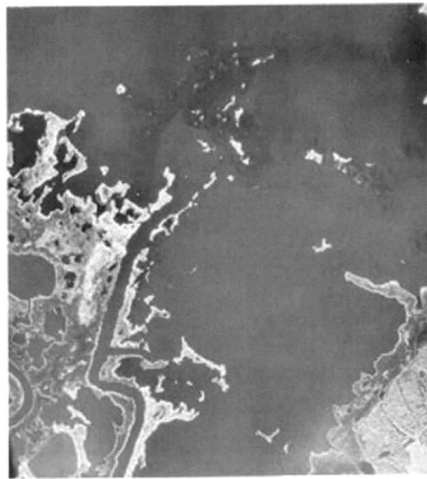
1938



1957



1972



1988







Declining marsh showing sediment along Shorter's Wharf Rd. October, 2000



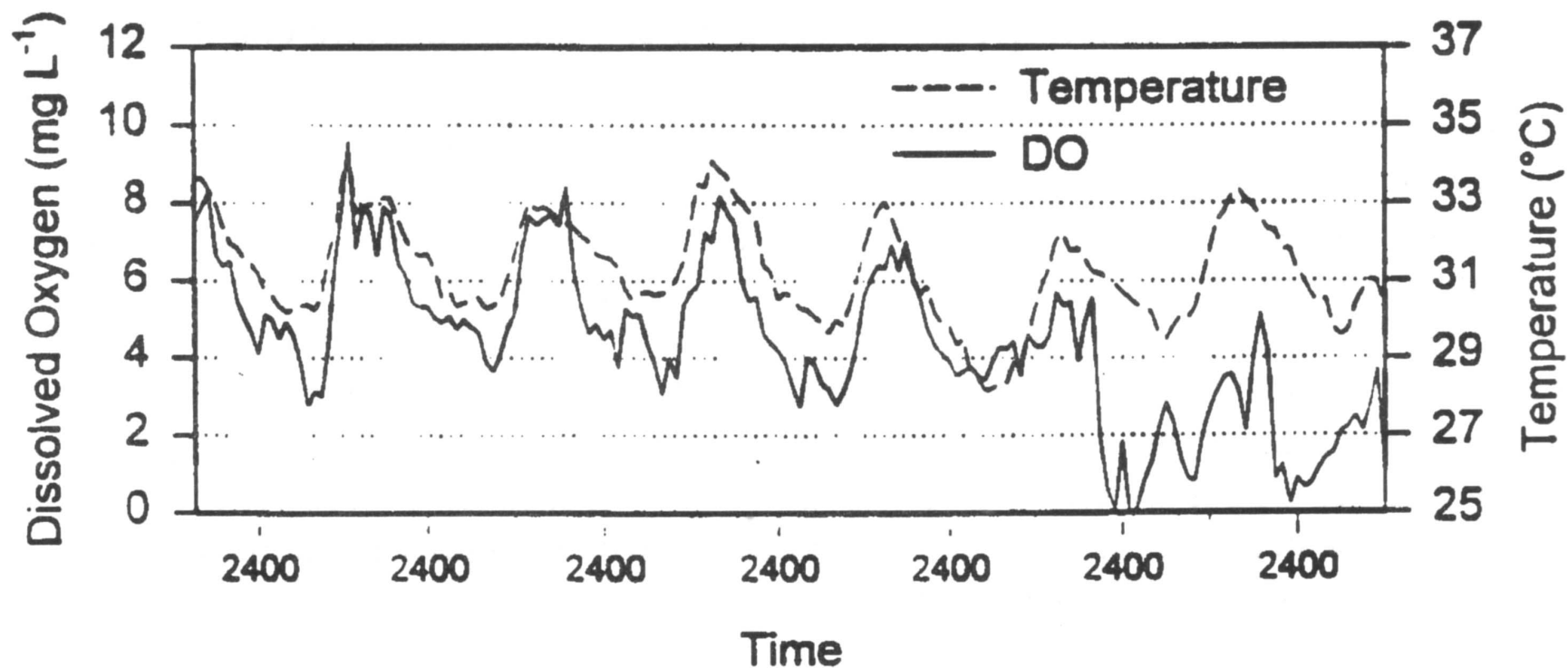
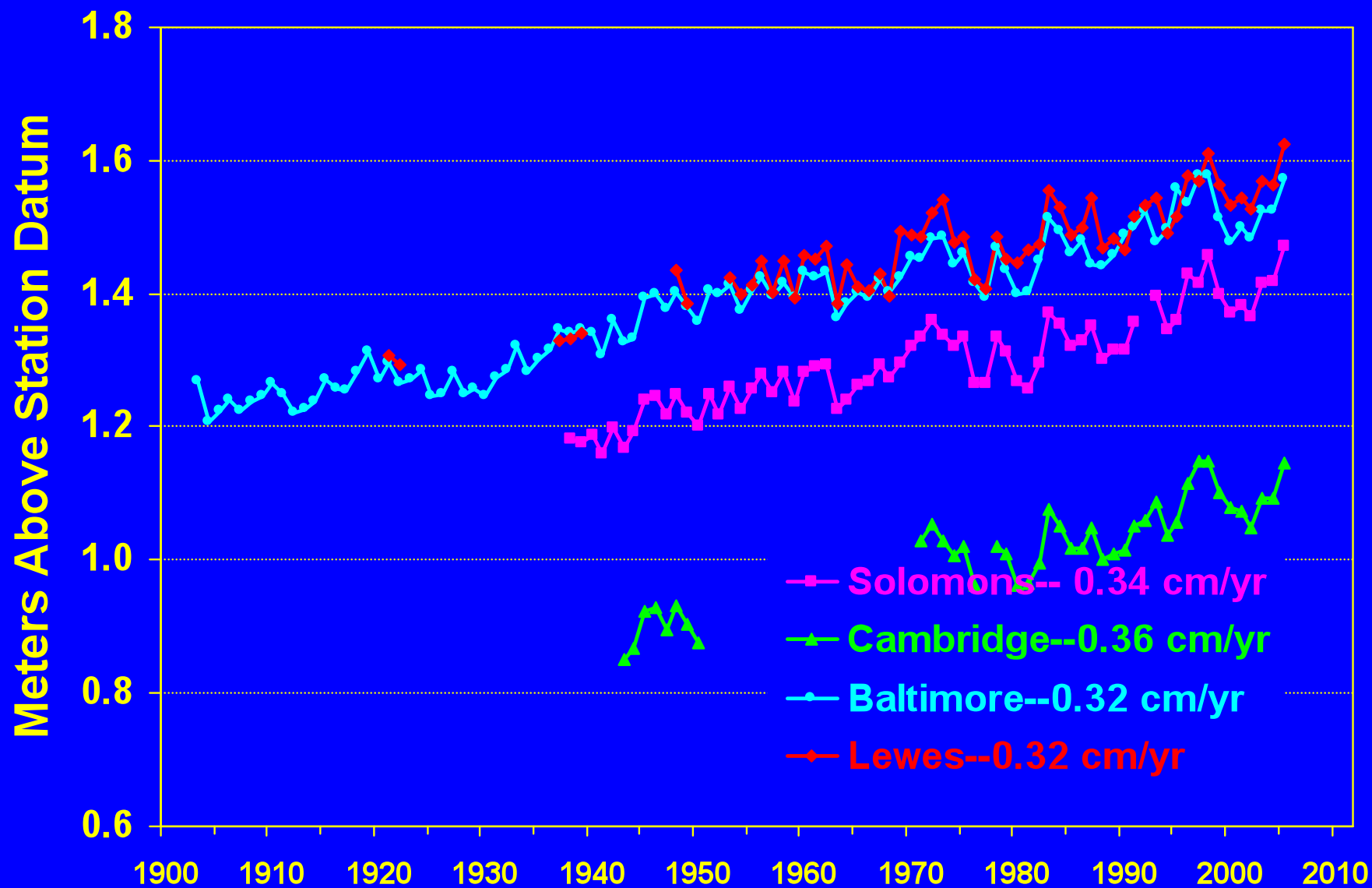
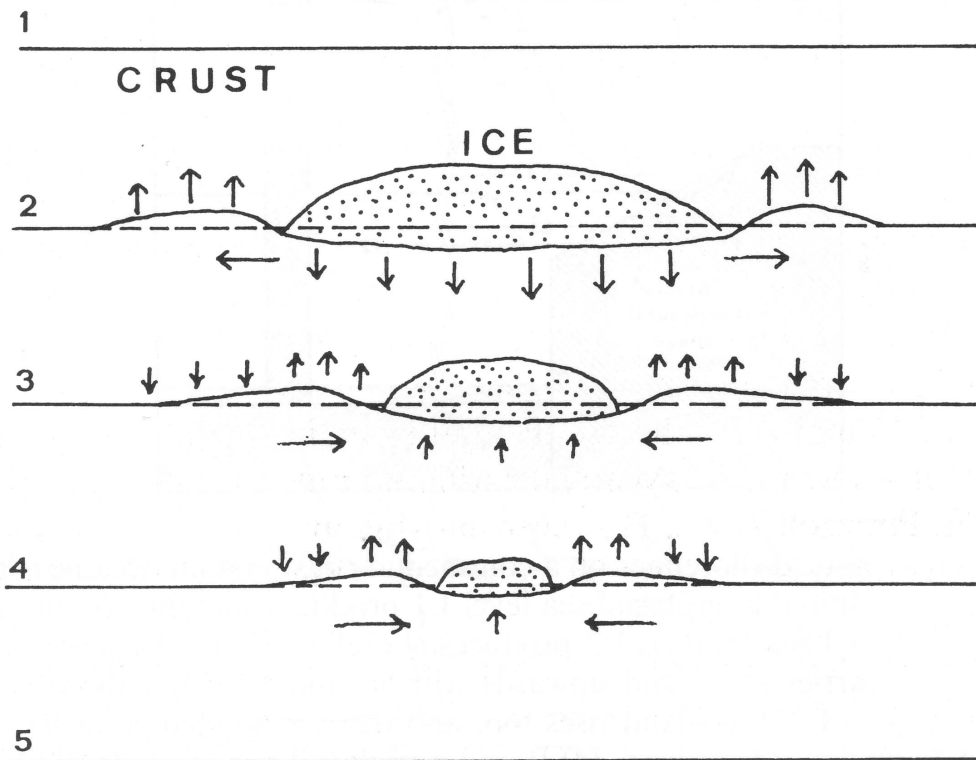


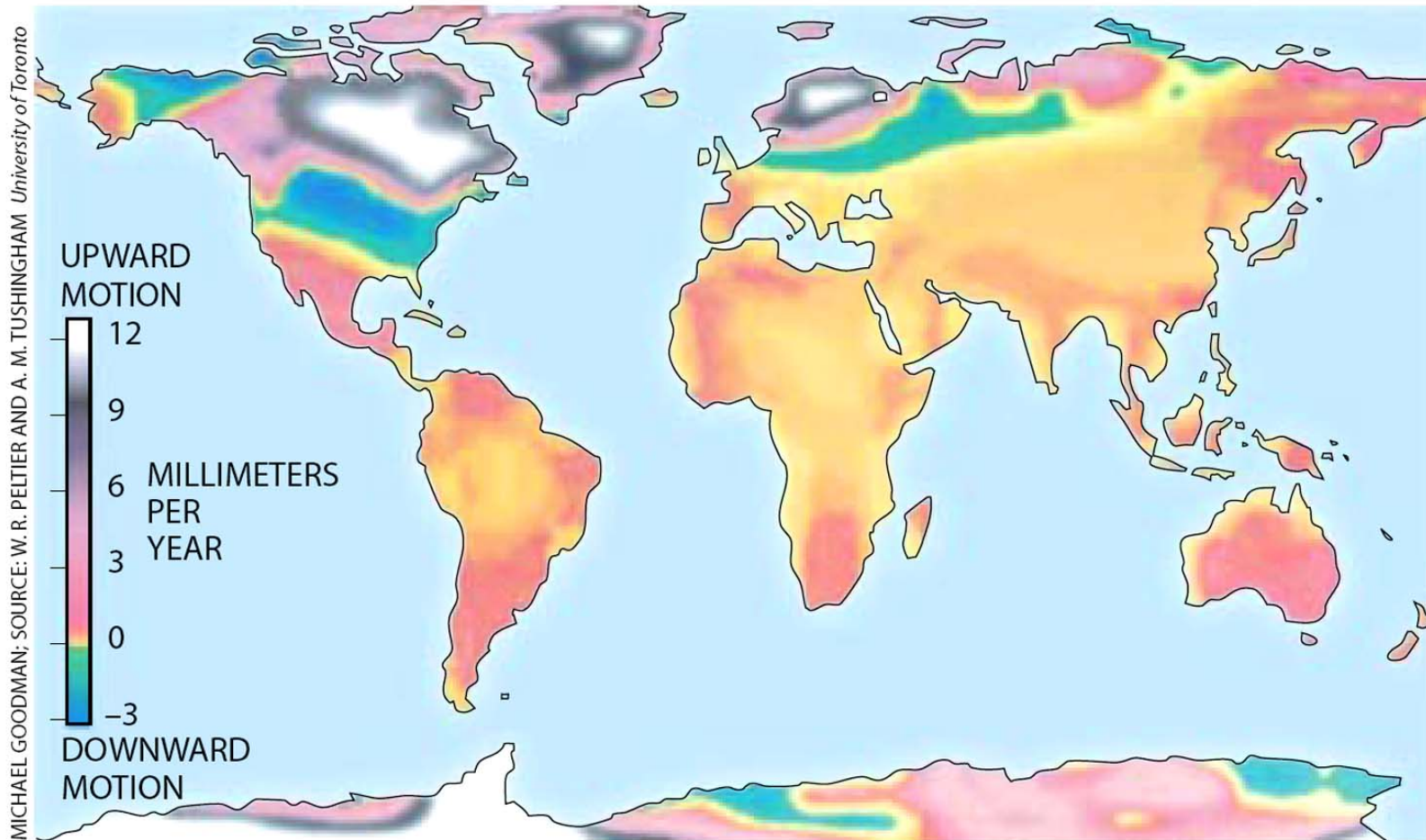
Figure 8. Dissolved oxygen concentrations in July of 1995 at Blackwater NWR. Data were collected with a Hydrolab data logger at mid-depth in approximately 1 m of water in the Blackwater River immediately east of the Rte. 335 bridge.

Annual Mean Sea Level in Chesapeake and Delaware Bays



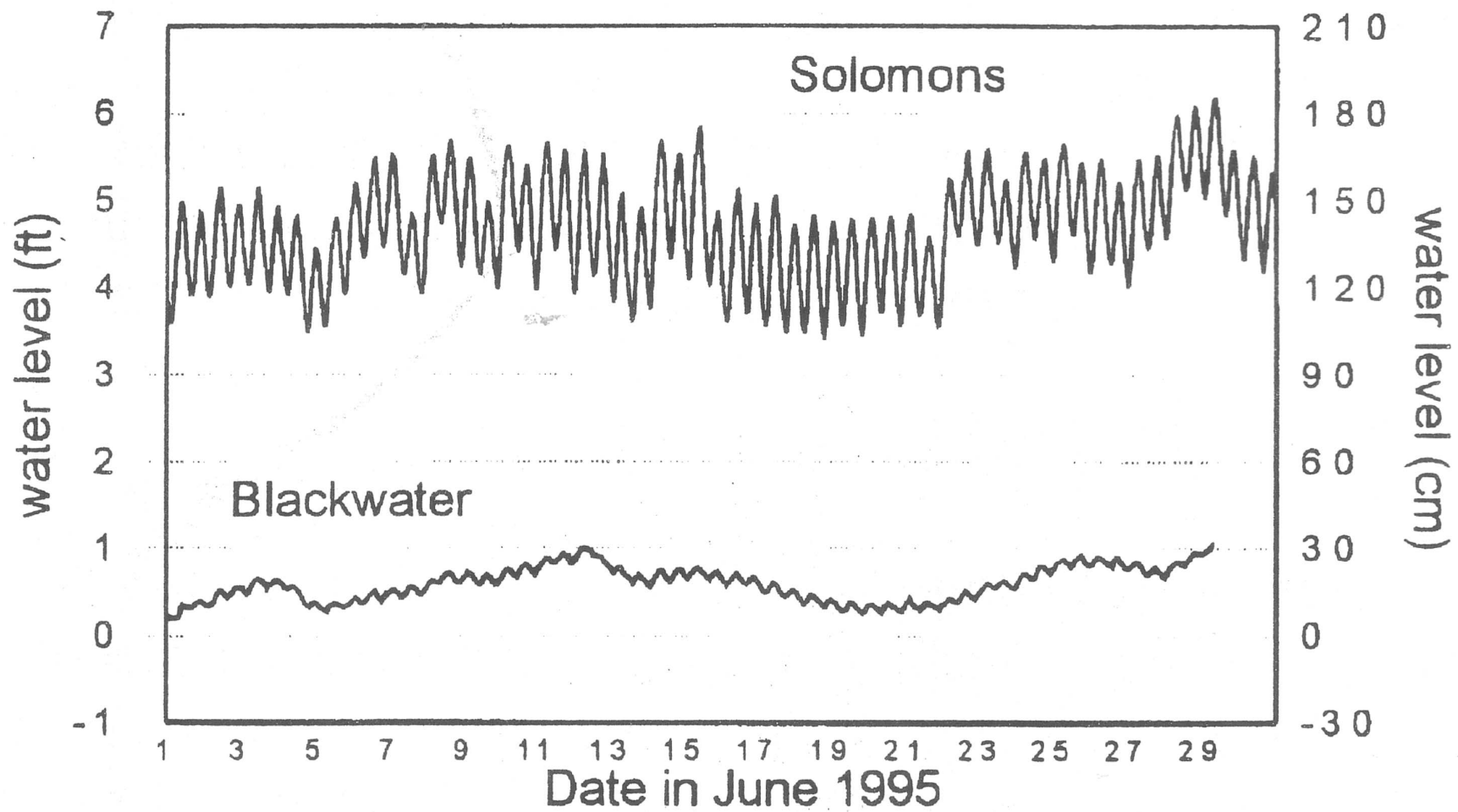
Relative Sea Level (RSL) depends on whether the land is rebounding or sinking (from past glacial activity) as well as local factors (subsidence) & Chesapeake Region is in the zone of forebulge collapse .





POSTGLACIAL REBOUND, the slow recovery from the deformation caused by weighty ice sheets, accounts for the vertical movement of the land in many parts of the world. These shifts, which have been continuing since the last ice age ended, affect relative sea level at the coastline in a manner that varies from place to place. Such movements can confound tide-gauge records obtained from coastal sites and thus complicate efforts to track the overall change in global sea level.

From: Schnieder D. Sci. Amer. 1997



From: Stevenson et al. 2000

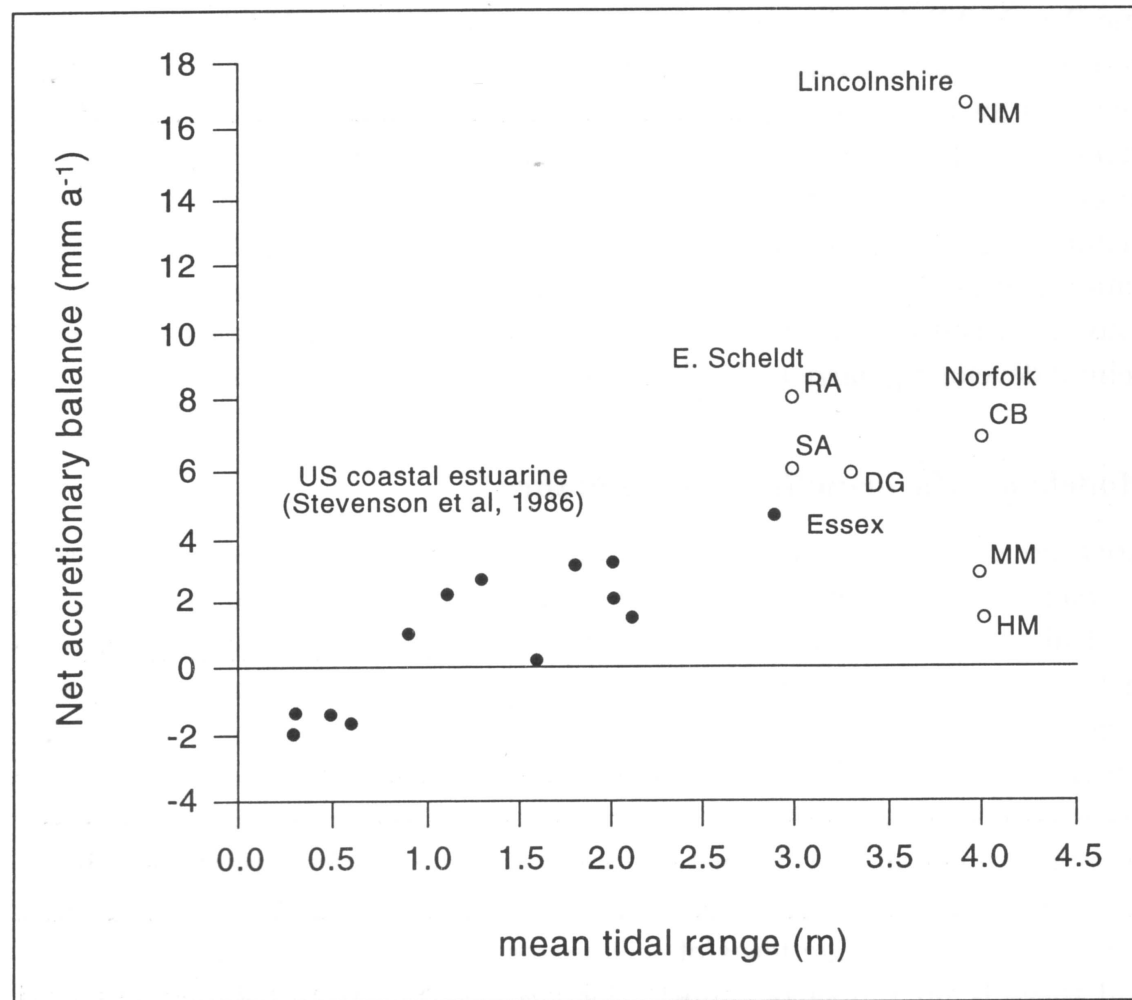


Fig. 5.6 Plot of accretionary balance (mean annual accretion – local relative sea level rise) versus mean tidal range. After French (1994): CB = Cockle Bight, Scolt Head Island; MM = Missel Marsh, Scolt Head Island; HM = Hut Marsh, Scolt Head Island; DG = Dengie, Essex; NM = New Marsh, Gibraltar Point; RA = Rattekaai, East Scheldt, the Netherlands; SA = St Annaland, East Scheldt, the Netherlands

Source: Viles, H. and T. Spencer. Coastal Problems. Arnold, London

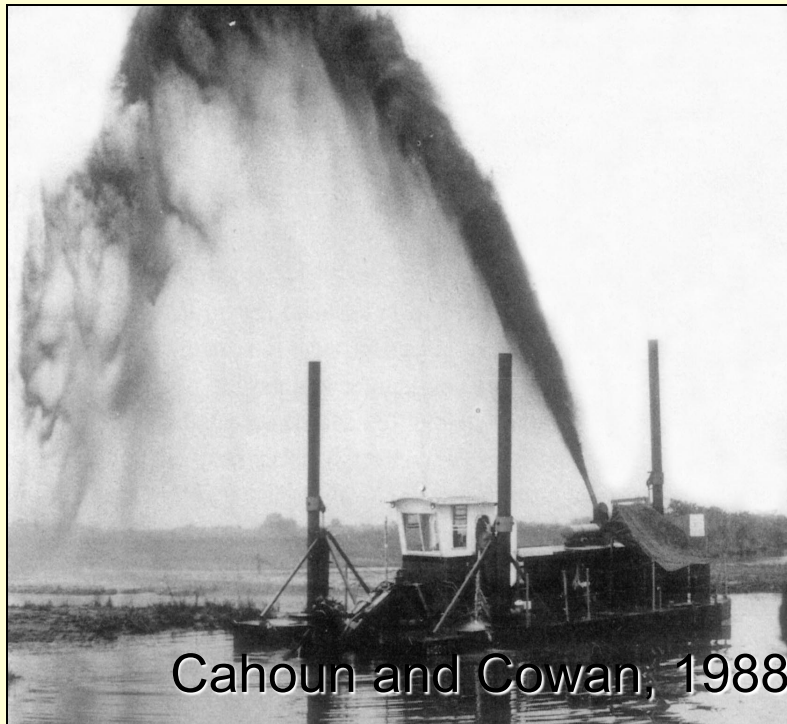
H.A. Viles and T. Spencer. 1995. Coastal Problems: Geomorphology, Ecology... Arnold, London

Sediment budget (MT yr⁻¹) for the Blackwater River system derived from monthly sampling from October, 1979 through November, 1980

Budget term	Total suspended solids (TSS)
<i>Inputs</i>	
Blackwater River	
ebb tides	1070
flood tides	500
net input	570
Little Blackwater River	
ebb tides	6580
flood tides	1880
net input	4700
total riverine inputs	5270
<i>Outputs</i>	
Lower Blackwater at Shorter's Wharf	
ebb tides	766,000
flood tides	41,400
net tidal output	724,600
net system export (riverine inputs minus net tidal outputs)	-719,330

From: Stevenson et al. 1985. Mar. Geol. 67: 213-235

Can declining marshes at Blackwater NWR be enhanced using local dredged materials ?



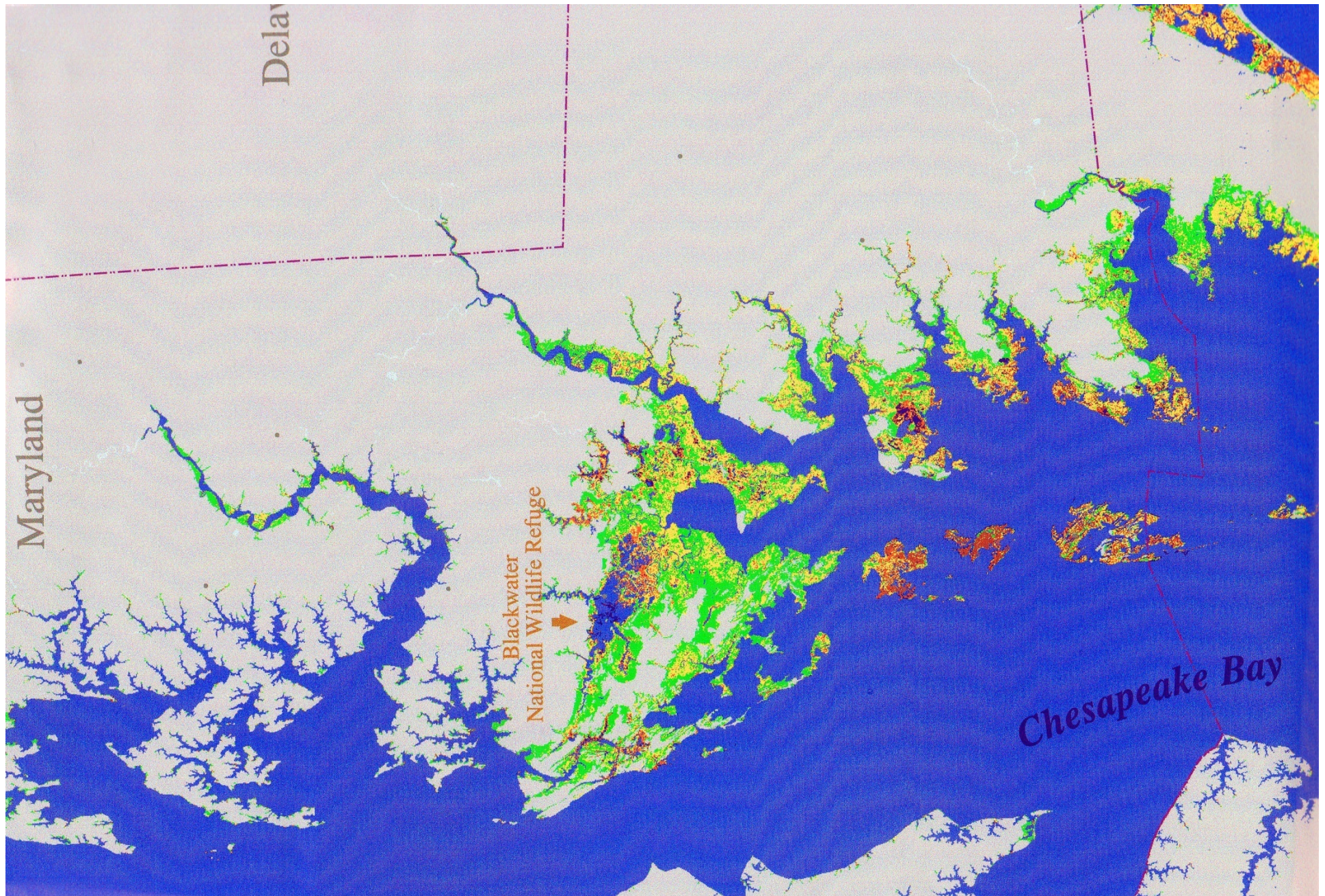
Thin-layer spraying of dredged materials on marshes has been used in Miss. Delta > 20 years.



Marsh at Shorters Wharf one year after “thin-layer application” of materials from Blackwater River.



The plant biomass at Shorter's Wharf in Blackwater R. was high at first.



MSCI Index: Healthy, Mod Deterioration, Severe Deterioration



Armoring shorelines at Cooks Pt –18 Apr 2001. As marshes continue to erode, & are replaced; buffering capacity is lost!



Living Shoreline at Aspen Institute on Back Wye R, Queen Anne Co, MD

Background- Poplar Is. was been reconstructed to its approx. size in 1847 using ~29 mill m³ dredged material from Upper Chesapeake Bay



Dike Construction - Armon



Cell 4 DX at Poplar Island after transplanting in late summer of 2003 showing *Spartina alterniflora* & *S. patens* zones



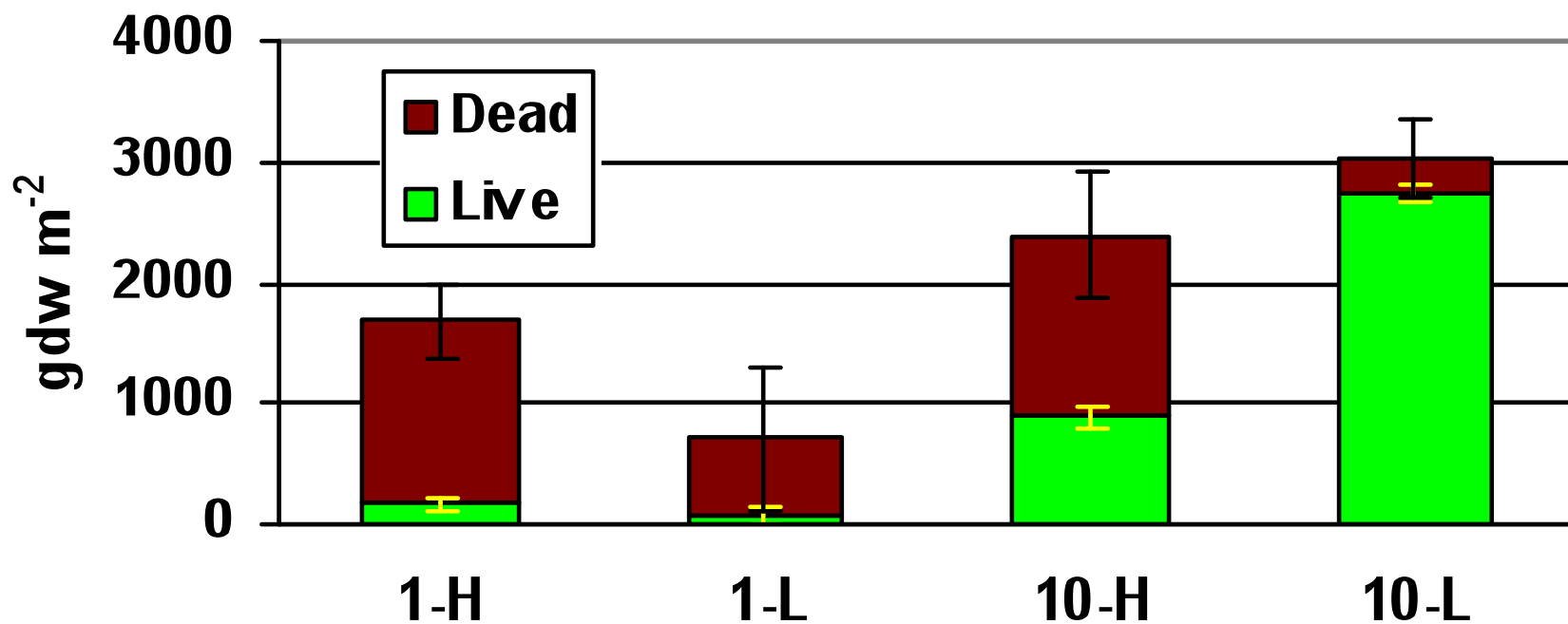


Poplar Island – July 2006

Photo by Jane Thomas
UMCES

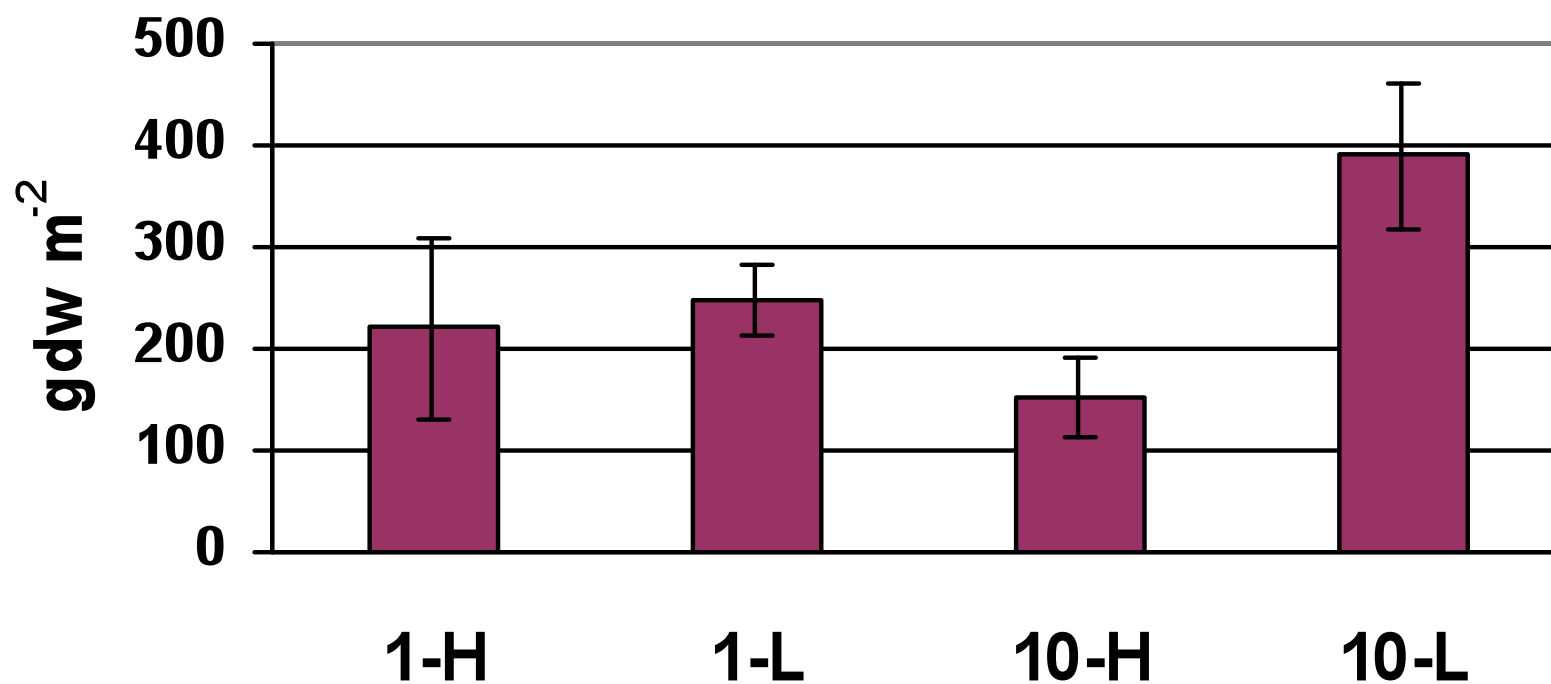
Cell 3D 2007

Aboveground Biomass

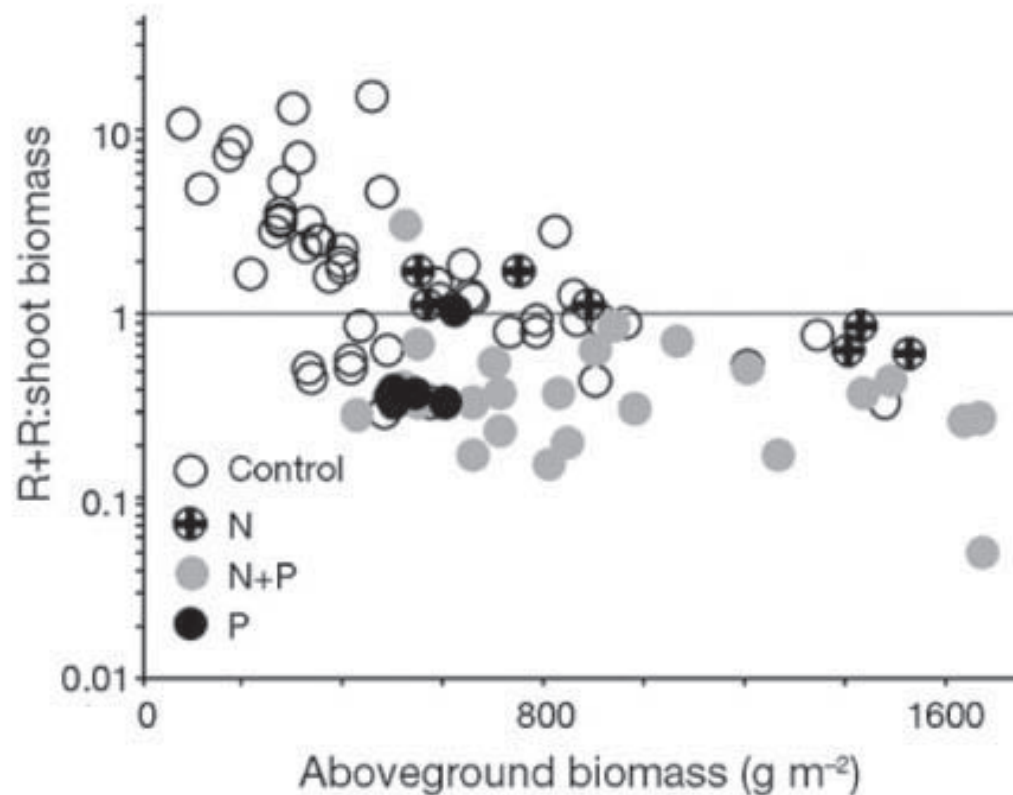


Cell 3D 2007

Belowground Biomass



Darby, F. and R.E. Turner. 2008. Effects of eutrophication on salt marsh root & rhizome biomass accumulation. Marine Ecology Progress Series 363: 63-70



**Poplar Cell 3D
Robust Low Marsh**



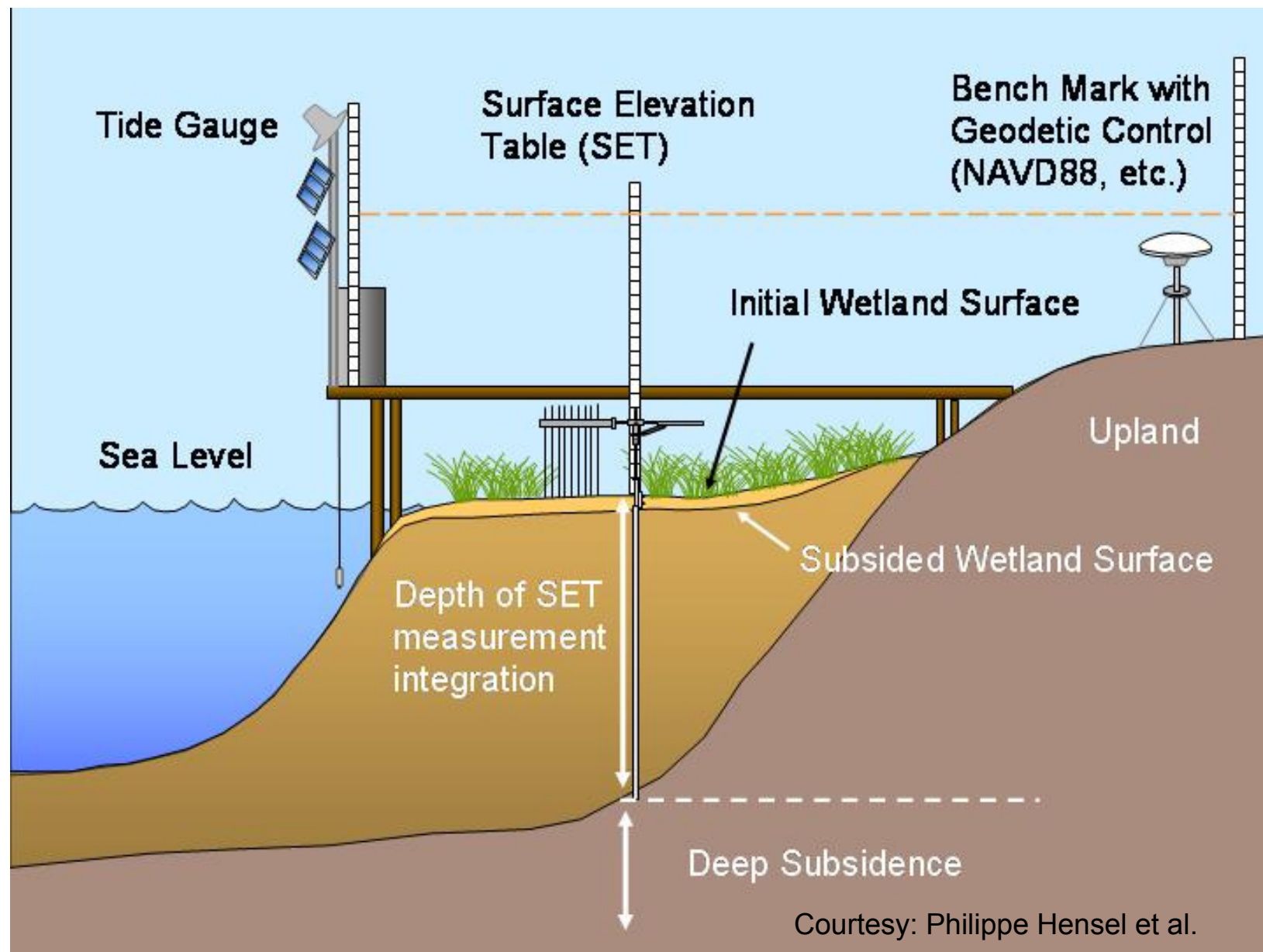


The surficial deposition at Poplar Island appears to have a large above-ground component (as well as fine grained silt) from the creeks. Will it be enough?

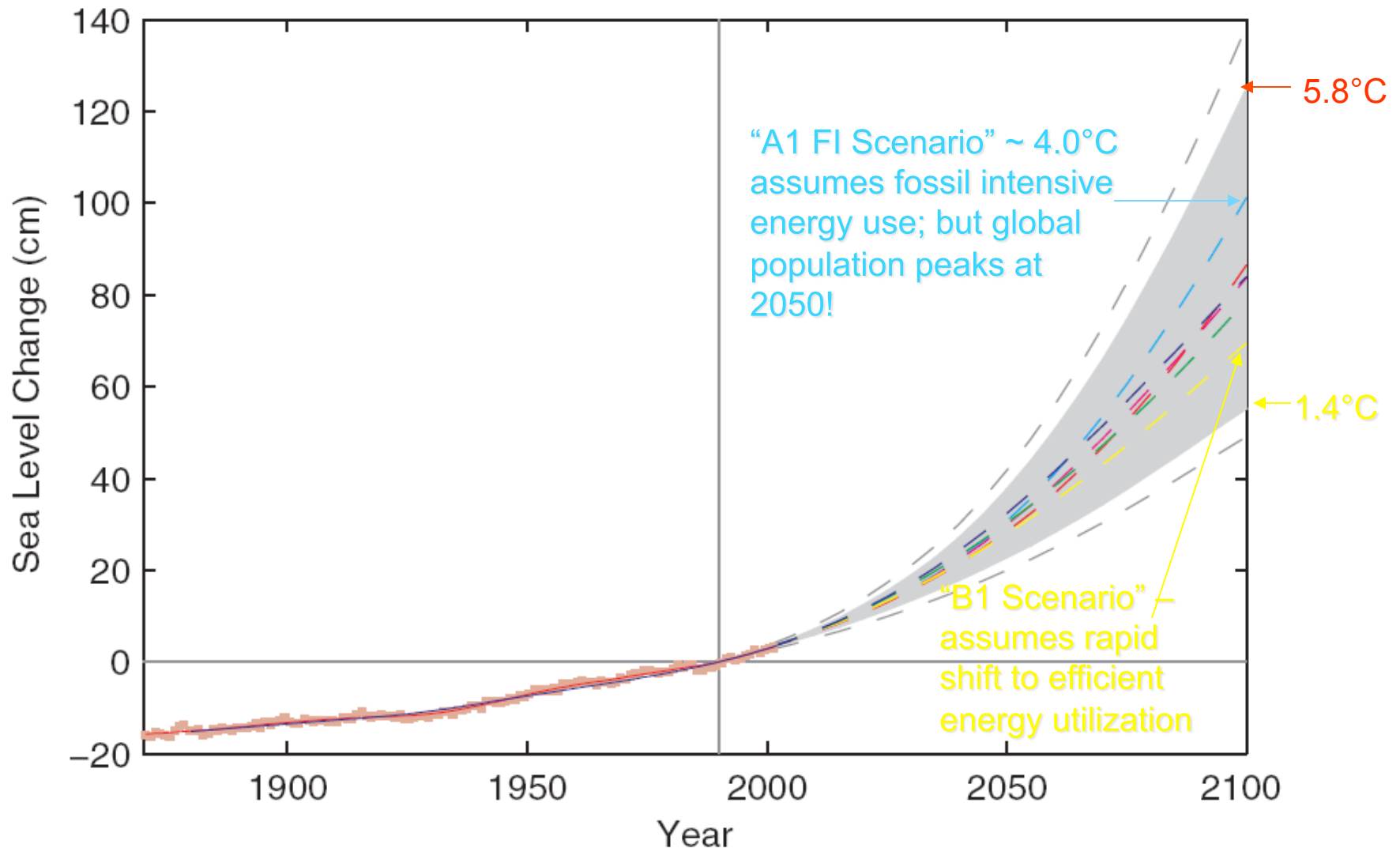




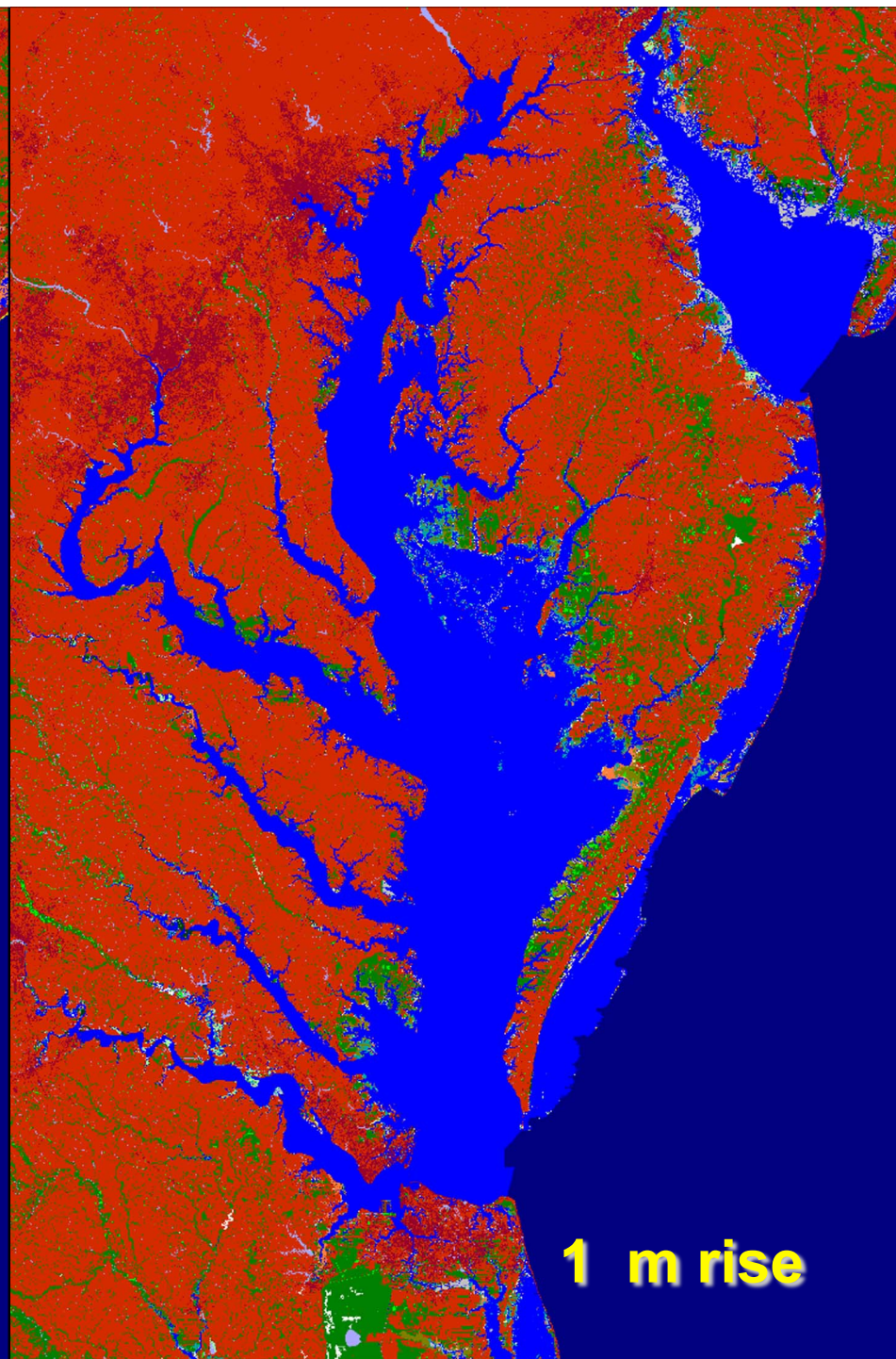
Philippe Hensel (NOAA-NGS), Jeff Cornwell, (UMCES) Justin Callahan (US-ACE) et al. have now Installed 15 rod SETs, at Poplar Island and hopefully we will have some answers. So far, the marker horizons which were laid down in 2006 in Cell 3D are in the 3-4 mm/yr range; barely enough to keep abreast of RSL in the Chesapeake.



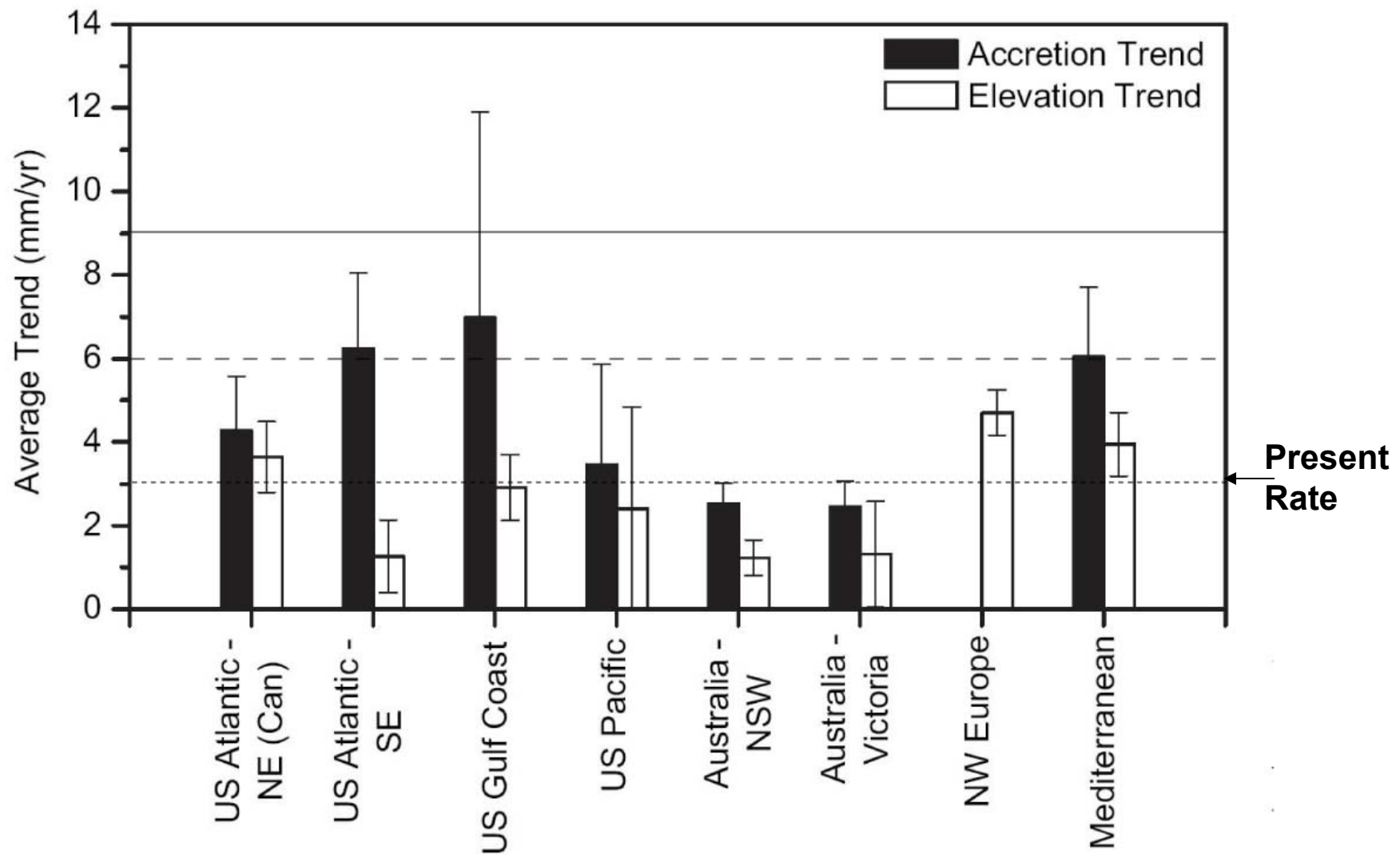
IPCC (2007) Estimates Global Sea-Level Rise (SLR) 19 - 58 cm by 2100



Using a proportionality of 3.4 mm/yr per 1°C rise, Rahmstorf (2007 - Science 315: 368-370) estimated global sea level rise could be 1.4 m by 2100 & could be higher on the East coast of US (Hu et al. 2009)!



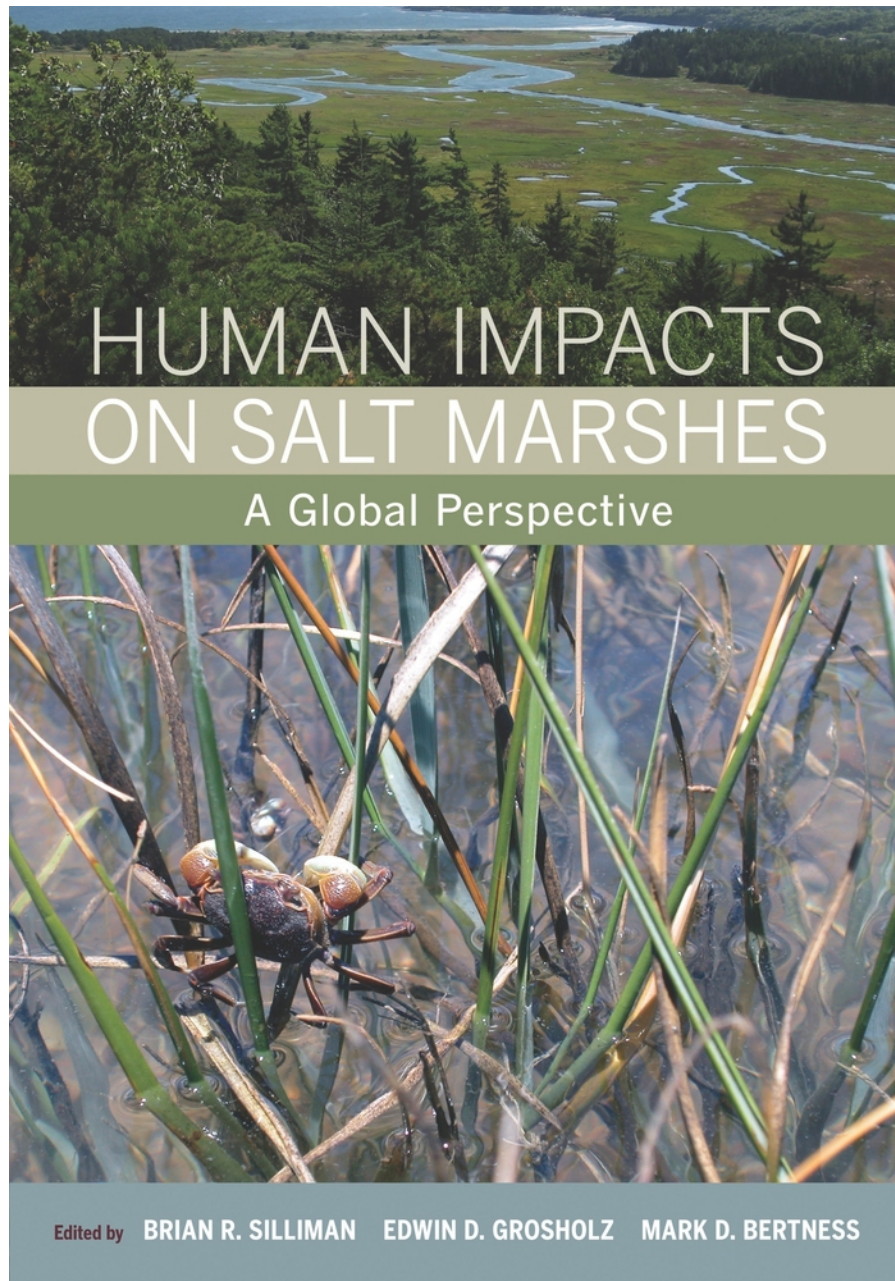
Cahoon, D.R., P. Hensel et al. 2006. Coastal vulnerability to relative sea-level rise, pp 271-292. In: J.T. Verhoeven et al. Wetlands and Natural Resource Management. Ecological Studies Vol. 19.



Impacts of Global Climate Change and Sea-Level Rise on Tidal Wetlands

J. Court Stevenson and Michael S. Kearney

It has been almost fifty years since the carbon dioxide measurements begun at Mauna Loa led to our understanding of the greenhouse effect of warming of the Earth's surface and sea-level rise. Shortly thereafter, Albert Redfield began coring sediments at Barnstable Marsh using ^{14}C dating to determine it had kept pace with sea level for almost four millennia. Redfield's early work led to the paradigm that marshes were in equilibrium with sea level. But by the 1970s, it became clear that large amounts of marsh worldwide had disappeared in areas as diverse as Louisiana, Chesapeake Bay, and Venice Lagoon. It is now an open question as to what extent the world's salt marshes are actually in equilibrium and able to keep abreast of sea-level rise. To be sure, this is a difficult problem to address, even using detailed sea-level histories during the Holocene period. The list of marshes that have deficits in accretion or are affected by lateral erosion process appears to be growing. At the same time, in other instances, high marsh zones are being encroached upon by the low marsh. Moreover, it is highly likely that sulfide accumulation in the root zone from increasing water levels due to rising sea levels will ultimately reduce the potential for vertical accretion. We conclude that, without additional sediment inputs, marshes are forced to accrete more organically to keep up with rising sea level. The highly organic sediments near the marsh surface are more susceptible to oxidation during periodic drought (or when subsurface groundwater inputs are diminished as a result of human activities), leading to ephemeral acidification events, especially after rehydration occurs via acid rain. Managers need to be especially careful that when creating impoundments, marsh surface sediments do not dry out, shrink, and oxidize. By the same token, every effort should be made to reduce fire (an oxidation process) on highly organic marshes. Additional steps that can be taken to improve marsh survival include reducing overgrazing of marshes by geese, muskrats, nutria, and snails. Ultimately, marshes can survive high upward excursions of sea-level rise if mineral sediment inputs are enhanced. Studies have documented that jet-spraying material on the marsh surface is an effective, if possibly a limited-scale, solution. In addition, new marshes can be created using dredged materials to offset areas where losses are unavoidable, though large projects may cost billions of dollars.



Edited by **BRIAN R. SILLIMAN** **EDWIN D. GROSHOLZ** **MARK D. BERTNESS**

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